when satisfactory, could not be duplicated under former management with certainty as to the result.

"All this is now changed; and the results are so uniform and certain, that, with a few hours of instruction in the manipulation of the apparatus, an ordinary laborer, with no technical education and with average intelligence, can secure results with entire uniformity.

"Dr. Gesner soon discerned that one of the chief defects in the former treatment arose from the fact that the steam superheated in a separate furnace, and conducted by pipes into the retort, was invariably cooled to the extent of several hundred degrees before admission, and came in contact with the heated iron at a much lower temperature.

"To remedy this defect and insure absolute uniformity of temperature between the iron and the superheated steam at the instant of contact, a peculiar but very simple form of superheater was devised, and inserted in the retort itself. The result was entirely satisfactory; and, after a number of experiments by him to determine the conditions necessary to insure the best treatment, the works were turned over to an employee, who has since operated them with uniform results.

"The plant now in operation is located at East Port Chester, near the extensive foundery of Abendroth Brothers, and consists of twelve vertical retorts with a capacity for the treatment of about twenty tons per day of the Gesner sanitary soil-pipe. The time required for each charge is about two hours.

"After the pipes have been lowered into the retorts by means of a traveller, the retorts are closed for about fifteen minutes, until the contents are heated to the proper temperature. Steam from a boiler at sixty pounds pressure is then introduced into the superheater, which it traverses, and from which it escapes at the temperature of the iron, upon which it acts for about one hour. A measured quantity of some hydrocarbon is then admitted with a jet of steam, followed again by a fixing-bath of superheated steam, which completes the process.

"The most extraordinary feature of the operation is that, as Professor Gesner positively asserts, there is no pressure in the retort, and no free explosive gases. The water-seals attached to the retorts show only slight oscillations, but not an inch of pressure; and when the covers are removed, and air admitted, there is no explosion, as there always is when free hydrogen or carbonic oxide are present, and as there always was before Professor Gesner took charge.

"The absence of pressure and of explosive gases is a proof that all the operations have been so nicely regulated as regards material used, quantity, and time of application, that a perfect absorption and union of the carbon, oxygen, and hydrogen with the iron has been effected.

"The protection thus afforded to the iron is not a mere coating, like paint, but an actual conversion, to a greater or less depth, into a new material, just as, in the process of case-hardening, iron is converted into steel. When properly treated, this material does not seem to be detachable by pounding, bending, hammering, rolling, or heating. The pipes treated at Port Chester have been immersed in baths of dilute sulphuric acid, and exposed to the salt air for weeks without change, while untreated pipes were quickly covered with red oxide or with sulphate of iron.

"The exact chemical composition of the material produced by this treatment has not been reported upon by Professor Gesner, but it is probably a carbide, hydride, and superoxide of iron. This would seem to be a necessary result, if, as is stated, the retorts when opened contained no free gases, neither hydrogen, oxygen, nor carbonic oxide. As these gases are necessarily formed, their disappearance can only be explained on the theory that they have combined with the iron, forming the three compounds of superoxide, plumbago, and the alloy of hydrogen and iron, for which Professor Gesner has proposed the name of 'hydron.'

"The plant now in operation at Port Chester has been designed simply for cast-iron soil-pipe, but Professor Gesner is preparing plans for a more extensive plant for the treatment of wrought iron and steel, to be erected at South Brooklyn.

"In the application of this process, each specialty will require a plant adapted to it, and a series of experiments to determine the exact conditions as to temperature, quantity, kind, duration, etc., to secure the best results, after which they can be duplicated indefinitely with any ordinary intelligence.

"The question is often asked, 'What is the effect of this treatment upon the tensile strength of the material?' This can only be answered by direct tests; but if the new material should not possess the tensile strength of the untreated iron, as in wires or rods, compensation can be secured by a slight increase in diameter. It is certain that in some specimens the treatment has increased the toughness and strength by the annealing process to which the material is subjected. Sheet iron of poor quality, that would break by bending, has been rendered tough and pliable.

"The cost of the process is said to be about one-fourth of that of galvanizing, while the durability under similar conditions promises to be greatly extended."

SUPPOSED SHOWERS OF METEORITES IN THE DESERT OF ATACAMA.

IT is now universally acknowledged, says a correspondent of *Nature*, that meteorites come from outer space, and that shooting-stars, whatever they are, have an extra-terrestrial origin. It is further asserted that a meteoritic fireball and a shooting-star are only varieties of one phenomenon. Indeed, after it is once granted that a meteoritic fireball is produced by the passage through the terrestrial atmosphere of a dense body entering it with planetary velocity from without, and that shooting-stars have an extra-terrestrial origin, it is a very fair assumption that a shooting-star is likewise a dense body rendered luminous during its atmospheric flight.

One great objection to this assertion is, that again and again showers of hundreds of thousands of shooting-stars have taken place, during which no heavy body has been observed to reach the earth's surface. The only known case of the arrival of a meteorite during a shooting-star shower was that of Mazapil, on Nov. 27, 1885, and that single coincidence may possibly be the result of accident. A sufficient explanation of this difficulty, however, is to be found in the small size of the individuals which produce the appearance of a shooting-star shower. That the individuals are really minute is proved by the fact, that, while the total mass of a large swarm, like that producing the November meteors, is so small that there is no perceptible influence on the motion of the planets, the number of separate individuals is almost infinite. It is established that the Leonid swarm must be hundreds of millions of miles in length, and some hundreds of thousands of miles in thickness; and in the densest part of the Bielid swarm, passed through in 1885, the average distance of the individuals from each other was about twenty miles.

Further, it is now acknowledged that comets are themselves meteoritic swarms, and Mr. Lockyer has lately brought forward spectroscopic evidence that the fixed stars and the nebulæ are similar to comets in their constitution.

The question therefore immediately presents itself, is the size of a meteoritic shower, on reaching the earth's surface, ever comparable with that of a meteoritic swarm, as manifested by a shower of shooting-stars?

During the present century nearly three hundred meteoritic falls on the earth's surface have been observed, and on only a single date, namely, Aug. 25, 1865, has there been observed a fall on two distant parts of the earth on the same day. On that date stones fell at Aumale in Algeria, and at Sherghotty in India; but as the times of fall differed by about eight hours, and the stones arrived from different directions, it is more than probable that the coincidence of date was accidental.

The most convincing proof of the actuality of such showers is furnished by the masses which have been found in the valley of Toluca, in Mexico. Their existence had been chronicled as early as the year 1784, yet in 1856 it was still possible to collect as many as sixty-nine. Belonging, as they do, to a single type, they lead to the conviction that they are the result of a single shower. But the region over which the fall took place is not large: the length of it is said to have been only about fourteen miles.

It is a question of a certain amount of interest as to whether there is any evidence of the actual fall of a shower of meteorites over a large extent of the earth's surface. Such evidence has long been supposed to be furnished by the plentiful occurrence of meteorites in the Desert of Atacama, a term applied to that part of western South America which lies between the towns of Copiapo and Cobija, about 330 miles distant from each other, and which extends inland as far as the Indian hamlet of Antofagasta, about 180 miles from the coast.

The generally received impression as to the occurrence of meteorites in this desert is well illustrated by the following statement of M. Darlu of Valparaiso, read to the French Academy of Sciences in 1845:—

"For the last two years I have made observations of shooting-stars during the nights of Nov. 11–15, without remarking a greater number than at other times. I was led to make these observations by the fact that in the Desert of Atacama, which begins at Copiapo, meteorites are met with at every step. I have heard, also, from one who is worthy of trust, that in the Argentine Republic, near Santiago del Estero, there is, so to say, a forest of enormous meteorites, the iron of which is employed by the inhabitants."

A study of the literature indicates that "the forest of enormous meteorites" near Santiago del Estero, understood by Darlu as significative of infinity of number, is really a free translation of a native statement "that there were several masses having the shape of huge trunks with deep roots," and that not more than four, or perhaps five, masses had really been seen in the Santiago locality at the time of Darlu's statement. There is a similar misunderstanding relative to the Atacama masses: it is clearly proved, that, at a date long subsequent to 1845, the desert was virtually untrodden and unexplored. In Darlu's time it was only crossed along definite tracks by Indians travelling between San Pedro de Atacama and Copiapo, and between the inland Antofagasta and the coast. In fact, it is established that the only Atacama meteorites then in circulation were all got from a single small area, three or four leagues in length, in the neighborhood of Imilac, one of the few watering-places on the track between San Pedro and Copiapo.

Since that time the discovery of rich silver-mines in the centre of the desert, and the working of the nitrate deposits, have led to vast changes; the desert has been more or less closely examined, and other meteoritic masses have been found. Still, the number of meteorites yet discovered, distinct either in mineralogical characters or locality, is shown to be, at most, thirteen.

One of them, Lutschaunig, is distinct from all the rest as being a chondritic stone; a second, Vaca Muerta, likewise differs from all the others in that it consists of nickel-iron and stony matter, both in large proportion; a third, Imilac, is a nickel-iron with cavities, like those of a sponge, filled with olivine; a fourth, Copiapo, is a nickel-iron with irregularly disposed angular enclosures of troilite and stony matter; the remaining nine consist of nickel-iron, virtually free from silicates, some of them showing no Widmanstätten figures when etched, others showing excellent figures more or less differing in character.

Now, in every meteoritic shower yet observed, the individuals which have fallen simultaneously have been found to belong to a common type. Hence it is reasonably certain that several distinct meteors are represented in the desert, and that the above masses are the result of several falls; and, this being accepted, the assertion of simultaneity of fall of two or more masses on the purely geographical ground that they have been found in the same desert, can be allowed no great weight.

It is thus clear that the meteorites of the Desert of Atacama afford absolutely no proof that enormous meteoritic showers have ever reached the earth's surface.

The general dryness of the air of the desert, and the rarity of rain, have been sufficient to insure the preservation of masses which have fallen in the course of many centuries unto a time when an exploration of a large extent of the desert has taken place.

That the meteoritic masses are far from being so plentiful as has been imagined is conclusively proved by the experience of Mr. George Hicks, one of the earliest explorers of the 23d and 24th parallels. Although much interested in their occurrence, he never found a mass himself, and he only obtained his first specimen after years of persevering inquiry from the Indians.

THE PULSION TELEPHONE.

A CURIOUS scene was enacted recently at a place called Child's Hill, on the Midland Railway, near London, England. What took place there, as vouched for by *Engineering*, was as follows. A party of gentlemen alighted from the train and ascended the embankment. Here one of them reached up to a wire stretched along the telegraph poles, and, placing the crown of his hat flat against it, he commenced a conversation with some unseen correspondent. The answers to his questions and remarks came back quite audibly to the group gathered around him, while those who felt sceptical as to the reality of what was being enacted before them, removed to a distance, and, pressing the wire against their ears and cheek-bones, heard the return messages for themselves. After some desultory conversation, the unknown speaker was asked to give a good shout, and in reply he jodelled with such vigor that a boy plodding his way along the cutting, at the opposite side of both up and down lines, looked up with amazement. He was at least eighty or one hundred feet distant, and yet he evidently heard the yell transmitted along the wire and received into the crown of an ordinary silk hat. It was quite impossible that he should have caught the original sound, for it was uttered in a cabin built on the side of the line at the Welsh Harp station, more than a mile away, and probably was not directly audible for one hundred yards. Those who were on the embankment knew that it was transmitted by means of a new mechanical telephone, for they had already listened to the same voice at Finchley-road station, which is $3\frac{1}{2}$ miles from the Welsh Harp.

When every one had satisfied himself that spoken words, whistling, and musical sounds could be received without special apparatus, the party re-entered the train, and went on to the Welsh Harp station, where they found several lines erected in the grounds of the local hotel. One of the lines starts from a small cabin in the grounds; it then proceeds to a post on the margin of the lake, and goes right across to a hut on the opposite bank. The distance is between a fourth and a third of a mile; and as this wire is not particularly tight, and only starts at a height of about ten feet above the water, it will be readily understood that it must lie for nearly its entire length in the mud which forms the bed of the lake. Another line traverses the gardens; its supports are formed by branches of trees, around several of which it is wound three times, and is then led off at an angle to its original direction. In another instance a row of statues are made to carry a line, which is laid upon any part of them which furnishes a convenient guide. This line is so slack that it can be bent into S form by the thumb and forefinger. The very various circumstances appeared, however, to make but little difference to the instruments, and in all cases conversation could be carried on with the greatest ease, and often could be heard a foot or two away from the receiver.

The instrument by which these curiously constructed lines were made to give such remarkable results is the property of the British Pulsion Telephone Company. It is the invention of Mr. Lemuel Mellett of Newton, Mass., and already several hundred instruments are at work in Boston and elsewhere. The construction is so exceedingly simple, that one is filled with wonder that it can effect so much. The receiver, which also acts as a transmitter, consists of a wooden case, divided into two parts by a metallic diaphragm held by a clip-ring and screws. In the centre of the diaphragm is a hole through which there passes the line wire, having at its end a button to take the pull. So far there is no special novelty to distinguish the telephone from the old pill-box and string. The new feature consists in a set of resonators placed over the diaphragm to re-enforce its vibrations. These resonators may be made in many different forms; those used on this occasion are spiral springs of various lengths, and made from wire of different gauges. One set of springs is festooned between the screws which hold the diaphragm, while others are held at one end only, and project upwards and inwards within the case. These resonators are chosen experimentally of such dimensions that each will be set into vibration by some one or more of the tones which are usually